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H. B. WALKER, President **RAYMOND OLNEY, Secretary-Treasurer**

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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.

(b) Farm Structures—buildings and other structures and related equipment.

(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.

(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.

(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

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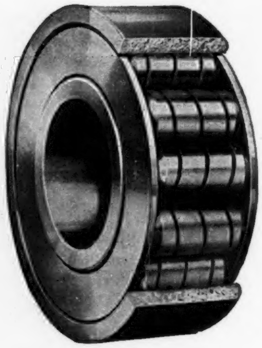


AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 5 NOVEMBER, 1924 No. 11

EDITORIALS

Machinery and Costs

LABOR is the biggest item in the cost of farm products. Agricultural engineering saves labor and reduces cost.

Whether it takes the form of reclaiming lazy acres, better buildings for less money, or better equipment working better and lasting longer, it reduces the cost of production to the farmer. Let the farmer increase his profits by increasing his selling price through better marketing methods if he can. It may, or may not, be within his power. It is within his power to accomplish the same result by reducing the cost of production.

That wet acre that he plows every year and gets only half a crop in return is a money loser. That stump that he is dodging in his cultivated field is another thorn in the flesh. By draining the wet acre and "shooting" the offending stump he makes cultivation easier, cost less and produce more.

Good farm operating equipment, working better and lasting longer, carries with it the idea of wise selection. Perhaps it is an extra strong team of horses; perhaps it is a light-weight tractor; or it may be a heavy tractor. If the side-delivery hay rake and the hay loader save the time of four men in the hay field on a hot afternoon, when the hay is ready to go in fast, it pays to get them to make hay while the sun shines and let them rest under a roof the rest of the time.

While it may often appear that too much equipment has driven some farmers to bankruptcy, there are two other factors that are usually bigger. First, many farmers do not house their machinery properly when not in use, or adjust or oil them properly when in use. Second, the high price of the land usually weighs more heavily on a farmer's shoulders than the high price of machinery, or the possession of too much machinery. The American farmer is not overstocked with machinery. He is understocked today in the right kind of machinery, and commonly overstocked with high-priced land. It is a sad comment on any system of agriculture that the cost of the land, exclusive of buildings, is more than ten times as much as the cost of the machinery used to operate the farm. In fact, machinery is only one-twentieth of the total investment of the average farmer, yet it saves labor which is more than half of the total cost of producing farm products. If $1000 worth of machinery or equipment on a farm saves one laborer, it pays interest on the investment as well as the principal in two years.

Fortunately good equipment does not always mean expensive equipment. Ira Haverberg's wheel-and-axle crane for putting the hay rack on the wagon didn't cost anything but an old wagon wheel and half a day's labor—both salvaged; yet is saves him the interest on a hundred dollars a year.

And we can make our machinery work better. F. W. Duffee, of the agricultural engineering staff at the University of Wisconsin, found that a mower draws only half as hard when the sickle is sharp as when in the condition used by the average farmer. He found too that not only the horsepower-hours per ton required to run a silo filler could be reduced about 10 per cent by reducing the speed from 750 revolutions per minute, as recommended by the manufacturers generally, to 550 revolutions per minute, but that machines actually have more capacity at the lower speed. Are these thing worth knowing? Machinery is not only more efficient, but it also lasts longer when run at the right rate of speed.

I end where I started. Cut down, not the volume of production, but the cost of production through labor-saving devices within reach of the farmer. Let agricultural engineers take a bold stand. When a reckless plunger comes for advice as to what equipment to get, tell him not to get any. Where the man without a pocketbook comes for advice, tell him to work by the month for some farmer till he saves enough money for a decent start. When Mr. Average Farmer comes, figure with him closely until you work out the thing that meets his particular needs. But when you know your man, and know that he is intelligently bent on lowering the cost of production, don't hesitate to advise him to build that barn, to buy that machine, or drain the wet swale through the cornfield, or "shoot" those stumps that have been hindering him in the past. Help him to reduce the cost of producing a bushel of potatoes or a pound of butter.

E. R. JONES

* * *

Research and Standardization

A FEW years ago a committee of agricultural engineers representing manufacturers of silo fillers and agricultural colleges attempted to formulate a standard method or code for rating the sizes and capacities of silo fillers. Because of the lack of basic data necessary for working out an acceptable rating method, they soon became convinced of the necessity of carrying on research work that would develop the facts needed.

Since that time some very important research work has been conducted at the University of Wisconsin and some fundamental data has been developed which is invaluable to the manufacturers of silo fillers. As soon as this line of research work has been carried sufficiently far to furnish the basic data that was needed, the difficulties of formulating the standards which the original committee started out to do will from an engineering standpoint at least, probably be largely overcome.

This case offers a very good example of the desirability in most cases of carrying out a program of research before undertaking standardization. This may not be true in all cases, but it is true for the most part.

During the past few years a great deal of thought, study, and time have been given to standardization in the farm-equipment industry, more particularly to that phase of standardization commonly known as elimination. And it would seem, in the light of experience in connection with the attempt to standardize silo filler ratings, and also in connection with the effort to have discontinued the manufacture of cutaway blades for disk harrows and of left-hand plows, the real approach to these problems in most cases is through a comprehensive program of research carried out by the farm-equipment manufacturers in conjunction with the agricultural engineering divisions of the state agricultural colleges, and these efforts coordinated through the A. S. A. E. Research Committee.

It would seem that future progress in the development of farm machinery to meet changing requirements is dependent more upon research to develop basic information than on any other one thing and that the big task for agricultural engineers, both in the manufacturing plants and in public institutions, is to formulate and carry out a comprehensive research program involving all phases of farm-operating equipment.

The Relation of Agricultural Engineering to the Farm Equipment Industry *

By H. B. Walker

President, American Society of Agricultural Engineers

THE past century has been one of epoch-making progress in the United States. No other nation enjoys the distinction of such rapid advancement in agricultural and industrial development during a similar period. It is less than 100 years since Cyrus H. McCormick developed the practical reaper which has meant so much to American agriculture. Following this American skill and genius developed many processes and methods of value to national development. Important among these were: vulcanizing of rubber, the invention of the sewing machine, the Corliss engine, the gas engine, the sulky plow, and the self-binder. In fact these represent but a few of the important discoveries, or inventions, contributing to the rapid development of our agricultural and manufacturing industries. During this time the United States of America, with approximately 6 per cent of the world's population, has been responsible for more than two-thirds of the epoch-making inventions of the entire world. Surely we have reason to feel proud of these achievements.

When we reflect on this phenomenal progress and consider the outstanding achievements of our inventors, the accomplishments of these perhaps overshadow momentarily other national achievements. But it is well to remember in this connection that, during the same period of these epoch-making inventions, American statesmanship, either through intuition or foresight, brought into existence our land grant institutions known as agricultural colleges. The purpose of such institutions is to promote the science of agriculture and the mechanic arts. Could it be possible that, as early as 1862, American foresight saw the reflections which were eventually to develop between the mechanic arts and American agriculture, and thus link these two together in our land grant institutions. Whether we can credit American foresight and statesmanship with this or not, it is true that American progress in agriculture has been influenced in no small way by the application of the principles of the mechanic arts in the design of equipment for use in agricultural production.

No small amount of credit for our agricultural progress belongs to those who, during this period of development, have been constantly applying mechanical principles to the design of labor-saving farm machines. It has been these machines which have contributed so much toward putting the individual American farmer in that enviable position of being the world's greatest and most efficient producer. Likewise it has been this influence which has changed American agriculture from an occupation to a business. Moreover, during all of this progress it has been possible to maintain and extend agricultural production with a constantly decreasing per cent of our population. Today only about one-third of our total population is engaged in the production of foodstuffs, the remaining two-thirds being engaged in other industrial and professional pursuits. Thus, not only has the agricultural industry profited by the use of efficient machines in farm production, but other industries have been made possible, and these have been developed in such magnitude as to make our country one of the foremost in the manufacturing field. These great industries, when coupled with an efficient agricultural production, give our country a national balance which has no equal on the face of the globe.

The mechanical applications both to agriculture and industry have developed common economic problems. Today it is quite generally understood that the agricultural and manufacturing industries are interdependent and one cannot long survive without the other. Surely this is true, but of all groups of manufacturers this applies most directly to those engaged in the manufacture of equipment used in the production of farm crops. It seems logical, therefore, that the farm equipment manufacturers should have a direct interest in agricultural colleges. It would likewise seem logical that agricultural colleges, charged with the promotion of the science of agriculture and the mechanic arts, should be interested in problems of research, education, and extension in the farm equipment field.

Our agricultural colleges, for the most part, have placed greatest emphasis upon livestock improvement, soil conservation, plant breeding, the control of insect pests, and plant and animal diseases. The achievements of land grant institutions in such fields are highly commendable, and they have placed agricultural colleges in the well-earned position of authority in all of these matters. On the other hand, in matters of study and research in farm equipment these institutions have not made such outstanding progress. Even though our land grant institutions were founded more than sixty years ago to promote study and research in the science of agriculture and mechanic arts, and in spite of the fact that courses in engineering have been developed in these schools for many years, it has been only within the last twenty years that such institutions have given any outstanding or direct recognition to the place of farm equipment in agricultural production. In fact only seventeen years have elapsed since a group of men, about fifteen in number, representing these educational institutions, had the temerity to meet together to found an organization to magnify the importance of farm equipment in agricultural education.

Origin and Growth of Agricultural Engineering Based on a Real Need

New conditions have produced new professions. Engineering, as a profession, is relatively new, from which many other professions have emerged, as changing conditions have produced the necessity. The place of farm equipment in the agricultural industry seemed to call for a new type of engineer, and thus at Madison, Wisconsin, in December 1907, the agricultural engineer came into existence through the founding of the American Society of Agricultural Engineers. I have the honor to address your association today as president of that Society. The activities of this Society have been very closely related to those of our land grant institutions. I might even say that the Society is a product of agricultural and mechanical colleges.

The agricultural engineer's greatest achievements have been in the educational field, where no doubt heretofore his greatest opportunities were found. About forty per cent of our total membership is now identified with land grant institutions in teaching, in research, and in extension work. Thirty-eight of our agricultural colleges have organized work in agricultural engineering. A majority of these recognize the importance of this field by having separate departments or divisions, where all matters relating to the use of farm equipment are headed up. Instruction in these institutions is provided: first, by regular college courses to train agricultural college students and a limited number of agricultural engineers for the professional field; second, by short courses to farmers; third, by extension service through the 2268 county agents throughout the United States ;and fourth, through secondary school train-

*Address before the 31st annual convention of the National Association of Farm Equipment Manufacturers, Chicago, October, 1924.

ing in the 2658 Smith-Hughes high schools scattered throughout the various states. Furthermore, in recent years there has been created, in the Bureau of Public Roads of the Department of Agriculture, a Division of Agricultural Engineering where all matters of an investigational and research nature are centralized, and where instruction and extension work in land grant colleges are correlated.

When one considers that this tremendous educational organization has been developed within the last twenty years, it must be admitted that our land grant institutions are at least not indifferent to the development of agricultural engineering. It has been the work of these departmens that has emphasized agricultural engineering extension in the various states. About forty agricultural engineers are now devoting their entire time to extension activities. These extension men depend upon the college departments for the subject matter which is being carried to the farmer and his family through the county agent system. Smith-Hughes vocational agricultural instruction now includes training of a farm mechanics nature requiring from one-fifth to two-fifths of the total time of the student. The training of teachers for this mechanical instruction in Smith-Hughes schools has fallen, to a more or less degree, upon the agricultural engineering departments at the land grant colleges. I would class all of these activities as an educational achievement of no small magnitude. This character of work will never be completed, and as yet it is but little more than started. However, the organization is complete in its essential parts, so the greatest remaining task, now before the agricultural engineering departments, is to get the organization to function smoothly and efficiently.

Cooperation of the Industry Essential to Agricultural Engineering Progress

In the past agricultural engineering has been catching up with the progress made by the farm equipment industry, during all the years previous to the establishment of agricultural engineering departments. Teaching material or subject matter had to be worked out. Instructors had to be trained to fill the scores of teaching positions created each year. Laboratories had to be equipped, and above all this type of engineering had to find its place in technical education. I think I may say with safety that agricultural engineering is rapidly catching up with itself. Its field of endeavor is at present well outlined. It is now in a position to look into the future and make plans for progress. In this we seek the cooperation and confidence of the National Association of Farm Equipment Manufacturers, an organization which, in my judgment, is more concerned than any other in the development of a program, which will continue to make the individual farmer of this country a bigger and more efficient producer, and, at the same time, continue to raise the standards of living of our rural folks.

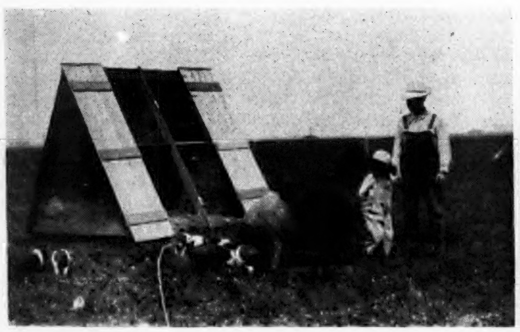
If the farm equipment industry has any need for direct contact with the educational program of agricultural coleges, surely this can be most logically accomplished through the department most closely associated with its work. The packing industry has its agricultural college contact through the animal husbandry departments, the fertilizer industry through the agronomy departments, the dairy industry through the dairy departments, and the electrical industry through the electrical engineering departments. Is it not logical that the farm equipment industry should have its contact through the agricultural engineering departments?

Agricultural colleges have always had an interest in manufacturing industries, but of recent years it has become a well-established policy to work with industry as well as with agricultural producers, since the problems of one are so closely linked with those of the other. These institutions, however, cannot in themselves effect the program of cooperation. Programs and policies are worked out when profits and progress can be most readily attained by such relations. How may such relations be improved with farm equipment machinery?

The purpose of the land grant college is three fold: the first, and perhaps the most important function, is teaching, but teaching to be most effective must be supported by research, which is, accordingly, the second function. The results of teaching and research should be expressed in a third function, namely, public service of value to industry and to agriculture. These three functions apply directly to agricultural engineering departments. I have already pointed out the educational activities. In this field we are better prepared than in any other, because so far it has received the greatest attention. Still our educational facilities are not perfect. Many institutions have inadequate housing and laboratory facilities as well as insufficient funds to supply the necessary personnel for teaching and research.

The manufacturing companies are to be highly commended for their support in furnishing institutions with farm equipment for educational purposes. Not less than two-fifths of a million dollars worth of loaned machinery is in use by the thirty-eight agricultural engineering departments in the land grant colleges. The cooperation of manufacturing companies in furnishing loaned equipment for educational purposes has been a great boon to agricultural engineering. It is a practice to be encouraged and improved by keeping the most modern and improved machines in these schools.

The place of farm equipment in agricultural production is worthy of a position on the campuses of our agricultural colleges, subordinate to none, and at least equal to that of other agricultural or mechanical departments. In matters



The rotation of hoglots and houses for healthy pigs is a cooperative project of the South Dakota State College extension service. The animal husbandman, the farm crops man, the animal disease control man, and the agricultural engineer, Ralph L. Patty, are working together on it. The agricultural engineer's job was to furnish blueprints of the house and arrange for rotation of hog pastures in the farmstead plan. The house is 7 by 8 feet and has a two-inch plank floor. Each house has a lot about 100 by 300 feet. The greatest disadvantage of this plan of hog raising is the extra labor required of feeding and caring for the sows and litters

of this nature representatives of the industry can be helpful. Your equipment is offered for educational work. Your interest in improvements for housing your equipment and for providing personnel for more effective education, if made in a direct and personal way, will carry weight with the administrators of our schools, as well as our law makers, who are responsible for appropriations for buildings and maintenance.

The quality of instruction offered by land grant schools in agricultural engineering should be able to stand the closest scrutiny by technical representatives of the industry. The improvement of instruction is a significant matter, since better education in the use of equipment has a growing value to the farmers. In matters of extension schools the closest cooperation should prevail between the colleges and your association. I am very glad to be able to state that definite plans are being made to promote a program of cooperation between the colleges and the implement industry in matters of this nature.

Research is the foundation of education and the leaven of agricultural and industrial progress. Much of the future progress of the farm equipment industry depends upon the discovery of fundamental truths based upon nature's laws. These discoveries cannot be made without organized thought and collective effort. Our land grant schools are sadly lacking in agricultural engineering research. During our progress the last fifteen or twenty years, time and incentive have not stimulated interest in research, but we have reached the place in our educational and commercial development where our future progress is limited to a very large extent by research. This is a matter of mutual interest.

Agricultural engineering research is of two kinds, viz: first, that relating to fundamental truths having wide and general applications, and, second, the application of knowledge derived from fundamental truths to the design of economic, labor-saving machinery and equipment. The first type represents a field of study of our colleges and universities while the latter becomes a proper field of research for the particular industry concerned. We have a need, then, of developing a program of research in our agricultural institutions along farm equipment lines, which will be of general benefit to the farm equipment industry. There is a need, on the other hand, for the development of more extensive research by each individual industry and in this there exists the necessity for the training and development of technical men to carry out successfully industrial research programs.

Farms Production Costs Must be Analyzed and Machine Efficiencies Known

In the farm equipment field we have studies to make of an economic nature, as well as in matters of fundamental truths. All engineering practice is tempered by economics. Heretofore, the economic advantages of farm equipment have been so apparent as to require but little thought of economic analysis. But times are changing. Farm production costs must be analyzed, and machine efficiencies must be known. In farm equipment we should be able to capitalize machines for use on the farm the same as labor-saving equipment is capitalized in the manufacturing plant. We must be able to do this in order to know when types become obsolete or inefficient in production. Sales talks or arguments cannot settle these matters. Figures and facts are necessary. This is a field of research of benefit to all.

We come now to the question of extension service to industries and public welfare. Public service is obtained when there is a feeling of trust and confidence between those served and those responsible for the service. In the farm equipment field the educational institution is in a position by direct and indirect methods to foster this feeling of confidence so necessary for service and mutual profit between the reliable manufacturer and the farm user of his equipment.

It has been recognized for many years by college men that the future of agricultural engineering depends upon men technically trained for this particular profession. Technical men are necessary to maintain high standards of instruction in our land grant schools, to conduct fundamental research work, and to carry into effect extension service. To meet this demand for well-trained men, a number of our prominent land grant colleges are training engineers for these particular fields. The training is primarily engineering, but includes sufficient instruction in fundamental agricultural subjects to develop the agricultural point of view so necessary in the solution of engineering problems relating to the development of the agricultural industry. In the educational field such technically trained men, according to our own measure of engineering standards, have been able to fill with credit the responsibilities arising in such fields of work. The agricultural group represented by the consumers of farm equipment look to these engineers in our land grant institutions for the development of mechanical methods and data relating to engineering in agriculture.

To be able to promote effectively this feeling of trust and confidence which must exist between the producer and consumer we feel, as agricultural engineers, that the equipment industry should have in their organizations similarly trained engineers, not only to work out problems in the design, production, and research in farm machinery, but also in sales, service, and distribution of products. The induction of such men into the implement industry will do much towards attaining that feeling of trust and confidence so essential to public service with increased profit resulting therefrom to both producer and consumer. Such relations would stimulate research and education, would make college extension efforts more effective and far reaching, and in time sales efforts would be more productive. Logical methods for the induction of such men into the farm equipment industry would complete, in a large measure, the link of organization for the improvement of public relations and commercial progress.

The Local Dealer Is an Asset in Extending Agricultural Engineering

I wish to mention another matter of importance in the development of relations between the implement industry and educational institutions. Community development is a part of agricultural development. A well-developed community has not only good roads, schools, and churches, but also local commercial institutions for the service and convenience of its residents. The retail implement dealer is a part of this makeup. No community is complete without this commercial service, yet the name "implement dealer" does not always imply community service. There is a great need for broad-minded, public-spirited men in this field. We now have many of them, but not nearly enough. These men must have a vision of their place in community development. They must realize the importance of farm equipment in agricultural production. They must be able effectively to present facts concerning the products they handle.

The local implement man with a vision of his function in the community is a great asset in extending agricultural engineering education, while the indifferent dealer may cause many educational efforts to become ineffective. Educational institutions, through their extension workers, may do some very effective educational work in the use of improved farm machines or household appliances, but no action may follow in actual installations, because in these matters the educational institution is not in a position to execute actions of a commercial nature. It remains, then, for the local dealer to sell the manure spreader, the cream separator, the water system, lighting plant, barn equipment, plumbing systems, or other appliances.

Thought without action is worthless. Agricultural engineering extension stimulates thought in better farm equipment; the responsibility of securing action lies between the consumer and the local distributor of equipment. Thus, agricultural engineering is concerned in promoting more cordial relations and better understanding between the agricultural college worker and those engaged in the distribution of equipment to the farms of this country. Such contacts are really essential and if properly developed will, I am sure, result in mutual benefit.

In summarizing the relation of agricultural engineers and agricultural engineering departments in land grant

colleges to the farm equipment industry I wish to emphasize the following:

First, that agricultural engineering departments offer the logical point of contact between the farm equipment industry and land grant colleges.

Second, that agricultural engineering departments must function primarily for the advancement of education through resident teaching, research, and extension in farm equipment for the ultimate purpose of making agriculture more efficient and profitable, but in this, they must function not only as a representative of the producer of farm products, but also as a representative of the manufacturer of farm equipment.

Third, that the farm equipment industry should foster the growth and maintenance of agricultural engineering departments in keeping with the importance of this work to agricultural progress.

Fourth, that more agricultural engineering research of value to the farm equipment industry should be undertaken by land grant experiment stations.

Fifth, that research in the farm equipment field must be carried on by the industry as well as by universities and colleges to keep up with commercial progress.

Sixth, that technically trained agricultural engineers are necessary, not only in education and research, but these may be profitably utilized in the farm equipment industry in the design, production, sales, distribution and service of equipment.

Seventh, that the local implement dealer is an important factor in local community development, and it becomes a responsibility of agricultural engineering departments and the farm equipment industry to cooperate with the implement dealer in making his business a real community asset.

In all of these matters I feel there is much of common interest between this association, the agricultural engineering departments of our land grant schools, and the Society I represent. I can pledge the support of the agricultural engineers in any program of education in line with the problems I have outlined. The agricultural engineer believes he can be of value to your industry, and we realize that our future progress depends in no small way upon the commercial permanency and success of the manufacturing companies comprising your association. New conditions produced the agricultural engineering profession. Does it have a field of service for you?

In closing I wish to read the following lines from James Russell Lowell's poem, "A Glance Behind the Curtain":

> New times demand new measures and new men:
> The world advances, and in time outgrows
> The laws that in our father's day were best;
> And doubtless, after us, some purer scheme
> Will be shaped out by wiser men than we,
> Made wiser by the steady growth of truth.

When Is A Bolt Tight?

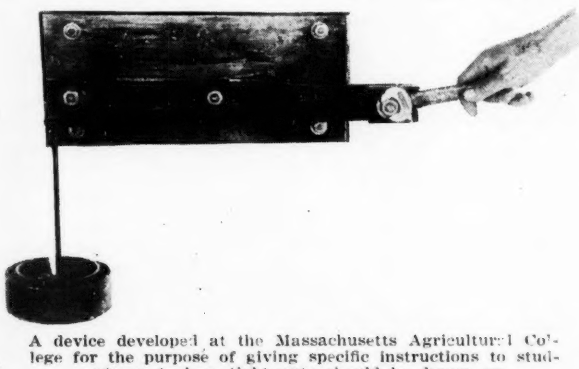
By C. I. Gunness

Mem. A. S. A. E. Professor of Rural Engineering, Massachusetts Agricultural College

IN assembling farm machinery in laboratory work, we find students have considerable difficulty in learning how tight bolts should be tightened. This is particularly true in such cases as the setting up of connecting rod bolts on automobile and tractor engines. The average student does not tighten bolts sufficiently, but once in a while one comes along who twists off the bolt. The problem is made more difficult due to the use of various types of socket wrenches using the same length of handle for large and small nuts. The experienced mechanic develops a "feel" for the required tightness, although very seldom will two mechanics set the bolts equally tight.

In order to be able to give specific directions to students as to how tight nuts should be tightened, the device shown in the accompanying illustration has been developed. It consists of an 18-inch scale beam fastened to a hollow pin at the right, and this pin turns in bearings provided in the main frame of the device. Bolts of various diameters can be inserted through the hollow pin and are kept from turning by a special washer.

As the nut on the bolt is tightened, there will be a tendency to raise the scale beam. Having determined the proper weight for a given size bolt, the student is told to tighten the nut until the weight is raised. This serves to give the student the "feel" of how tight the nut should be tightened.



A device developed at the Massachusetts Agricultural College for the purpose of giving specific instructions to students as to how tight nuts should be drawn up

Obviously any type of wrench can be used. A table showing the weights for bolts of various sizes is provided. The device is fastened on the wall in the laboratory where it is available for students at all times. If at any time students are in doubt as to how tight a particular nut should be tightened, they put in a bolt of the same size in the device, put on the proper weight, and tighten until the weight is raised using the wrench they expect to use on the job. In this manner they are able to check up their intuition at any time.

In the first model of this device, a spring balance was used in place of weights. This was not considered satisfactory due to the springiness introduced by the balance. With the present arrangement the nut is tightened under working conditions.

A bolt of given size will, of course, stand a different degree of tightening depending upon the grade of steel, fineness of thread, type of washer and lubrication of thread and washer. These factors can be allowed for in the table provided with the device, although in most cases this would not be practical except possibly as different values may be given for U. S. Standard and S. A. E. threads.

There are two or three methods for determining the proper weight to be used for a given bolt. One is to accept the intuition of an experienced mechanic by adding weights until he says that the nut is "tight". Another is to determine the weight which brings the bolt to its elastic limit, or actually breaking it, and basing the safe load on one of these values. A third method would be to calculate the proper torque. The proper method for determining these values and the actual values to use will serve as matrial for a subsequent article.

EDITOR'S NOTE: The foregoing is a good example of new ideas that are continually being developed by agricultural engineers—ideas that are well worth passing on to others. The dissemination of just such ideas as this is what makes for progress in the agricultural engineering profession: and AGRICULTURAL ENGINEERING offers an ideal medium for that purpose.

Relation of Large Machine Units to Production *

By Ernest B. Haight

OTHER things being equal, it is self-evident that the capacity to produce farm crops increases in direct proportion to the size of the machines used; a 12-inch plow will plow twice as much ground in a given time as a 6-inch plow; a 12-inch two-bottom gang plow will plow twice as much ground as a 12-inch walking plow, and so on. This being true, rather than undertake to give figures on acreages, etc., for different sized implements, would it not be better in analyzing this subject to deal more largely with the reasons for the continuation of older and less efficient machines and methods on so many farms and the possibilities of hastening the adoption of improved machinery on such farms?

The many improvements that have been made in farm equipment and methods during the past century are generally recognized. In a few years we have progressed from the cradle and the flail to the combined harvester-thresher which permits two men to cut, thresh and clean twenty acres of grain per day. In about the same period the wooden plow, which turned an indifferent furrow covering perhaps an acre per day, has given way to immense plowing outfits which will cover from twenty to thirty acres per day. From a bundle of brush, a split log, or a few planks fastened together and drawn over the plowed ground by oxen or horses, covering from five to ten acres daily, there has been developed a variety of types of scientifically constructed steel harrows, packers, pulverizers, etc., which, when used behind a modern prime mover will cover from fifty to one hundred acres or even more in a day, and do much better work than the earlier makeshifts. Mention should also be made of the recent rapid development of the smaller units of prime movers and machinery suitable for use in connection with the average-sized farm enterprise.

In view of these improvements and the possibilities they offer for increasing the output per man on American farms, it might, at first glance, seem remarkable that such equipment is not in almost universal use by American farmers. There are many farms in the country today where grain is still being cut with a cradle and bound by hand; one-horse walking cultivators and walking plows are used extensively in large areas of the country, and so on. Why this state of affairs, when such efficient equipment is available?

Before attempting to answer this question, let me suggest that the farming industry is not the only one that does not fully utilize the improved equipment and methods which have been developed and are available to it. A casual observation will convince anyone that only comparatively small percentages of any industry utilizes the very latest and most efficient methods and equipment available to that industry. Is all city hauling done with motor trucks? Are all manufacturing plants fully equipped with the latest and most efficient machines? Far from it. Take the plants manufacturing automobiles, a few of them are using the latest and most efficient machine tools, turning out the various parts in large quantities and at a minimum expense. Their shops are designed in accordance with the very best shop practice so as to keep all the material moving in one direction, with no doubling on its track and no lost motion. Other shops are less efficiently equipped; yet they are all manufacturing a similar product to be sold in a competitive market. So long as the demand is good and the prices fairly high, they will all make a profit, though the less efficiently equipped shops will obviously make the smallest profit and when adverse market conditions arise naturally they will be the first to suffer.

There are a number of reasons for this varying degree of efficiency in the equipment of both factories and farms. In the case of a manufacturing concern equipped with old-style machinery which is still serviceable, very often its present business is not of sufficient volume to justify the increased investment necessary to install the most up-to-date and efficient equipment, and the men responsible for the directing of the business do not have adequate assurance of the sufficiently large increase in the business to justify the required expenditure. In other cases, the location of the plant may be such is to prevent the utilization of the most efficient machinery and equipment; in still others a difference in the raw materials used may have the same effect, and so on. But if one asked business men their reasons for not employing the most up-to-date machines, the majority of them would doubtless reply truthfully that their business was not large enough to justify it. Many farmers would give the same reason, but it is a fact that it is much easier to enlarge a farm enterprise than most any other business.

It is obvious that the farmer who can make use of the most efficient machines can produce his crops at a lower cost than a farmer who is not so well equipped and who endeavors to raise the same crops. While it is probably well known to all who are intimately acquainted with agricultural problems that the farming business is, in the true sense of the word, a competitive one, the impression prevails so generally among people unacquainted with agriculture that there is no competition in farming, that attention should be called to the fact that the price of farm products is determined to a considerable extent by the cost of production on those farms on which the bulk of the crop is produced. For example, when the price of wheat falls to, say, $1.00 a bushel, those farmers who are well enough posted on the cost of producing wheat on their farms to know that they cannot produce it at a profit for $1.00 a bushel will, of course, stop raising it, unless it is especially desirable in their crop rotation for seeding grass, or serves some other purpose which will justify its continuance in the crop rotation when the receipts from the sale of the grain itself will not cover the cost of harvesting it. The same thing happens as the price falls to other levels; as the price goes down, more farmers must quit raising it, the same as in a manufacturing business. This has the effect of reducing the amount of wheat produced in those sections where conditions are not particularly favorable, and at the same time tends to increase the amount grown in the sections best adapted to its production. As prices increase, the reverse holds true. When the demand is such that the price level rises to a point where farmers, who have not been growing wheat, believe they can make a profit, they will begin planting wheat.

Desirable to Increase Production per Man by Using More Machinery

It is obvious that those farmers who are unable to utilize the most efficient machines and methods, or who are located on poor soil, must necessarily be the first to discontinue growing a crop as prices fall. It is the influence in its broad aspect which determines to a great extent the type of agriculture followed in any community. Soil and climatic conditions, of course, are a primary influence, but as these in turn affect the utilization of certain machinery or methods, it is apparent that the equipment problem is also important.

The desirability of increasing the production per man through the use of the most efficient machinery in all industries is most obvious. It is a generally accepted fact that during the next few years there will be keener competition between the commercial interests of the various nations than previously, a condition which we are in right now as Europe is trying to recover from her disaster. This competition is not to be considered as restricted entirely in

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industries other than agriculture. The most fertile and generally desirable farming lands in this country has already been settled, and is being tilled to a great extent. Most of this land has a comparatively high value. But there are several other countries where there are still enormous tracts of very fertile, low-priced land which has never been put under the plow which will be brought under cultivation in the years to come, and such cultivation will be carried on by means of the most improved American-made farm machinery, or imitations of it. Enormous possibilities can be seen in putting under cultivation the vast fertile lands of Africa, South America, India, and parts of China and Russia, just as soon as these countries become awakened and establish stable political and industrial relations. Who knows but that one of these countries may, in the not distant future, become the granary of the world?

In view of this outlook, it behooves the people of this country to make use of the most efficient equipment and methods in all lines of industry, including agriculture.

To Meet Foreign Competition American Farmers Must Use More Machinery

The most important problem which today confronts the agricultural engineers of this country, as well as all other agencies engaged in promoting agricultural development, is to assist in the utilization to a greater extent than ever before of existing improvements in agricultural equipment, in order that the vast majority of American farms may be organized and equipped on a basis which will enable them to compete successfully with those farmers in other countries who will be operating under highly favorable conditions with regard to land values and modern equipment. If this is not done, it will be only a matter of a few years before we will be importing large amounts of staple farm products from other countries where American-made machines are being used efficiently under favorable conditions, permitting successful competition with the farmers of this country.

We may well take pride in the progress which has been made in developing improved farm machines in the past and look forward to greater achievements in this direction in the future. But we must not lose sight of the very important fact that only a very small percentage of the farms of this country are today making use of such improved equipment as is available. Of what avail are such machines as the harvester-thresher, the tractor, the motor cultivator, and so on, when only a small percentage of the farmers of the country are utilizing them at the present time?

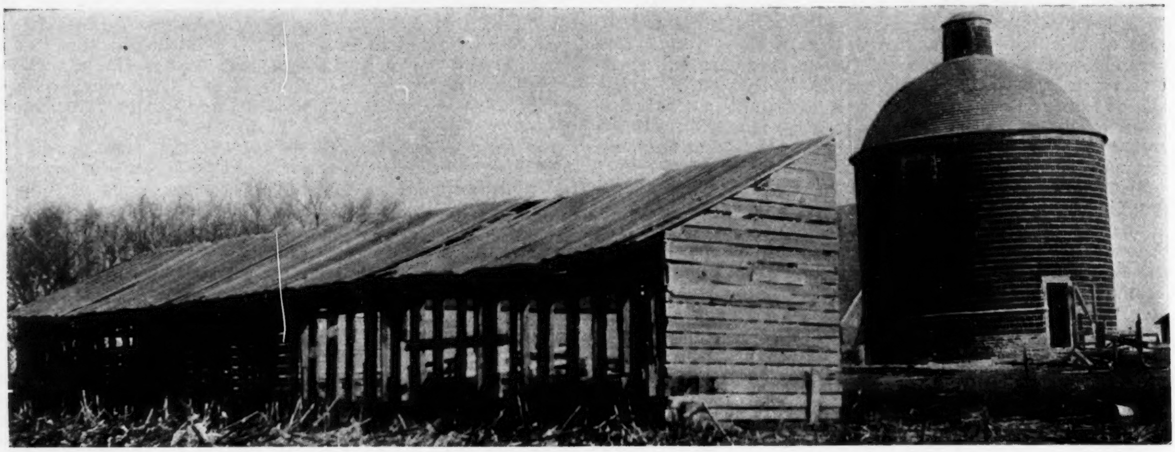
A few people undoubtedly will question the desirability of having every possible effort made to hasten the adoption of improved machines by farmers. Thousands of dollars worth of advertising of all kinds is being turned out to accomplish this purpose, and nearly all literature which reaches the farmer contains articles extolling the virtues of modern farm machines and telling him he should be up-to-date and make use of all such modern equipment. At the same time there is a dearth of practical suggestions as to how he can use such equipment with profit.

The desired result cannot be accomplished simply by telling the farmers of the country about these large and improved machines, how well built they are, the number of anti-friction bearings they contain, the beautiful shades of paint used on them, etc. Most farmers are already aware of the existence of such equipment and will admit the advantages it possesses. Many who are not using it would be willing to adopt it on their farms today, if they could only see to their own satisfaction how they could utilize it with profit.

It must be borne in mind that a great many farmers do not require any advice whatever regarding the management of their business—they are competent to conduct it to the best advantage and profit. To influence the others, what is needed is to point out to them the conditions under which this improved equipment can be utilized to advantage, and then tell them how they can make their conditions meet such requirements. Suggestions must be practical.

It would not be practical to suggest to the publisher of a small weekly paper with a circulation of two or three thousand that he should obtain an octuple press such as is used by the publisher of a large metropolitan daily with several hundred thousand circulation. It could be truth-

Faced with an ever-increasing foreign competition the American farmer is being forced to meet that competition by increasing the acreage farmed under one management to permit the more extensive and more efficient use of modern equipment, so that a higher production per man at lower unit cost may be obtained by the use of larger machine units.



A significant illustration of the old and the new. An outstanding example of what agricultural engineering means to the farmer. The crib at the right is scientifically "engineered:" the other is not

fully pointed out that the octuple press turned out papers several times faster than the small one, cost less per copy of operating expense, that the use of such modern equipment was a sign of progressiveness, and that since it would do the work so much faster it would permit of doing a much higher quality of work. Furthermore, that since it would not be kept busy all the time on the small paper it could be used to do outside work. It is not probable that such arguments as these would carry a great deal of weight with most small publishers. The strongest and only really valid argument of those mentioned would doubtless be that relative to doing job printing for others, and in many cases small publishers do install presses of greater capacity than their own needs demand and then keep presses reasonably busy and have them earn some money by doing job printing with them. But many publishers do not care to go into the job printing business, and many farmers do not care to get into the business of doing custom work for neighbors.

There is no doubt whatever that the purchase of some of the larger farm machines is an excellent investment for a small farmer who will use them for custom work when not on the home farm, and thousands of farmers are trying, at least, to make some money from such work. At the same time, there is a limit to the amount of custom work which can be done in any community, and the fact that a farmer has time to use a machine for such work is proof that the home farm is not large enough to keep its equipment busy during the working season. While some farmers may find custom work profitable, the machines would usually prove even more profitable where the owner keeps them busy on fields from which he will receive the entire profit from the crop.

The principal reason which will justify the installation of a large press in the case of the publisher is to have a circulation which will require nearly the full capacity of the machine. And the principal justification for the purchase of most of the improved equipment on farms today is to have a sufficient acreage for it to handle to keep it busy during a large part of the working season. This fact is so obvious and has been so fully demonstrated on thousands of farms in actual practice that it should be unnecessary even to touch upon it. But, strange to say, it is the one point which receives very little mention in the reading matter which reaches the farmers of this country, either in agricultural publications, catalogs, or other literature extolling the virtues and capacity of large and improved farm implements.

On the contrary, the farmer is constantly being told that the tendency in this country is toward smaller farms and more intensive cultivation. When he is urged to buy a tractor or other machine which will multiply his efficiency and permit him to do the work on his present acreage in much less time than was required by old methods, he is told that he can do a better quality of work and farm more intensively, and obtain a greater yield per acre, which will make such equipment just as valuable to him as to his neighbor who is growing the same crops but who grows a much greater acreage of them, using about the same amount and kind of equipment.

Analyzing the effect of larger machines on the size of farms, as already stated, production increases practically in direct ratio to the size of the machine. This being the case, it is self-evident that to produce a given quantity of foodstuffs the larger the machines used, the fewer will be required; and it naturally follows that the fewer machines used, the fewer the men needed to operate them. Other things being equal, the acreage required to produce a given amount of foodstuffs will remain the same, therefore, the fewer men, the more acres tilled per man—all of which is just another way of saying that larger implements increase the acreage one man can farm.

Is anything more logical than the fact that a man who uses four-horse implements can do practically twice as much work in a season as one who uses two-horse machines? Then cannot the man who uses four-horse tools farm twice as many acres as the man who consistently uses only two-horse equipment? And cannot the man who uses a tractor which will do more work than four horses, farm still more land? Yet we frequently hear the statement that there is a tendency toward small farms in this country. If such were actually the case, then the inventors and manufacturers of labor-saving farm equipment should hang their heads in shame and retire, because if the production of machines which increases the amount of work one man can do and the acreage which he can till is resulting in one man farming fewer acres than in the past, their work would have gone for less than nothing.

The Present Tendency is Continually Toward the Larger Sized Farm

But such is not the case. Some people believe we are tending toward smaller farms. They have gotten this idea by glancing at the figures in census reports as to the total number of farms of different sizes and the increase in the number of so-called farms of less than twenty acres and as small as two acres, but if the text accompanying these tables is read carefully, it will be seen that the increase is more apparent than real. Furthermore, if they would stop and think of the thousands of small country homes

and estates which are included in this group of so-called farms, they would realize it is not "farming" which is tending in this direction, but that the figures only indicate a natural consequence of the tremendous increase in our total and urban population, since thousands of city workers desire to live and do live on small places outside of cities near the railroads and trolleys. These "farms" are nothing more than homes with large gardens. They are not supporting the family and are an entirely negligible factor insofar as the food supply of the nation is concerned. They have very little more right to be termed "farms" than has a garden in the back yard of a city home.

But where is this increase in small farms occurring? And what section of the country should be selected as most fairly representing American agriculture if we want to study any such tendencies? Surely not the South, where the most important crop for the period covered by the census report was cotton. Cotton, let us understand, is one staple which is still being raised largely by hand methods because no entirely successful picker has yet been developed. This has resulted in it being grown principally in acreages small enough so that one negro family could pick it by hand. In the South, to be sure, there has been a tendency ever since the Civil War to break up the old plantations into smaller farms, and there is a great deal of land leased out to negroes in small plots which the census reports would list as farms, which are really only parts of a large farm which is being managed by a system found most profitable in many sections of the South.

According to the 1910 census, the twelve states included in the section of the country designated as the east north central and west north central groups, including North and South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Michigan, Ohio, and Indiana, raised 65 per cent of the total crop production for the year that the census was taken. This is not so bad a record for only twelve states of the Union; and in view of this they are justly entitled to be considered as representative of our agriculture.

Modern Machinery Can be Used More Efficiently on the Larger Farms

Now what do we find as to the tendency in the size of farms? In the east north central group, which includes Wisconsin, Michigan, Illinois, Indiana, and Ohio, there were 12,000 less farms in 1910 than in 1900, or 1.1 per cent decrease, with only an increase of 1.4 per cent of the total acreage in the farms in these states. We find there was an increase of 8,000 in the number of so-called farms of less than 20 acres, which was an 8.2 per cent increase. However, there were 33,000 less farms in the 20-to-49-acre group, and 9,000 less in the 50-to-99-acre group. Now, it did not take 8,000 of the larger farms to make that increase of 8,000 under 20 acres, but if it had there would still be 41,000 comparatively small farms missing and these are in the groups which may rightfully be termed small farms, ranging from 20 to 99 acres. Where did they go? Why they, with more land from some of the farms of over 500 acres, helped make an increase of 22,000 farms from 100 to 499 acres. If there is any tendency shown by these figures, it is certainly towards the fairly large and efficient sized farms.

As to the west north central states, we find an increase of only 4,000 farms of less than 20 acres, and this was a 10 per cent increase for the size, showing there were not a great many such small farms there before. There was a falling off of 18,000, or 16.9 per cent in the 20-to-49-acre farms, and 30,000, or 14.5 per cent in the 50-to-100-acre group. But there was an increase of 13,000 in the 100-to-174-acre farms, and 58,000 in those of from 175-to-499-acres. Nor is this all. There was an increase of 19,000 in the 500-to-999-acre farms, and of 2,000 in those over 1,000 acres. We must note, however, that there was an increase of 15.7 per cent in total acreage in farms, that is, there was this amount of land being farmed in 1910 which had not yet been settled in 1900. But the thing we are interested in just now is the "tendency," and it certainly is not toward smaller farms in this section.

But these figures show more than simply that the tendency in our most important agricultural states is toward the larger and most efficient sized farms, where modern equipment can be used to advantage. They also bring to our attention the fact that while a great many of the channels through which the farmer is supposed to receive valuable advice regarding his problems were carrying statements of a tendency toward small farms and intensive tillage, several thousand individual farmers saw that the solution of their biggest problem was to have enough land to make an efficient sized farm, and they acted accordingly. This throwing together of small farms to make a larger one and the buying or renting of an additional field or two has not been done by farmers on the advice of anybody. Rather, it has been done in spite of contrary advice.

It might also be well to add that since 1910 several thousand farmers in these states have bought tractors; and an investigation showed that one out of every three of those farmers increased the size of their own farm approximately 100 acres soon after buying the tractor.

Now it would seem that since so many farmers increase the size of their farms so as to use modern equipment efficiently, in spite of advice to the contrary, this tendency could be accelerated by pointing out to all farmers through the agricultural press, farm-equipment advertising literature, and all other channels the desirability of this action.

And now a few words as to the intensive tillage advice and the "little farm well tilled" fallacy which is still a popular theme among some city people who tell the farmer how to manage his business. It is a very common statement that the farmer who has less than 100 acres is fully as much justified in buying modern machines as his neighbor following the same system of farming but with a greater acreage, since he can make the larger equipment pay because it will cost a little less per acre of work done and he can also do more thorough work and use more intensive methods, thus offsetting the other advantages which the owner of the larger farm possesses. Such arguments roll off some people's tongues like butter off a hot knife.

There is no intensive farming practice which the small farm can use to advantage in the production of staple crops, which the larger farm cannot use to even greater advantage. Let us take two corn-belt farms of 80 and 240 acres, respectively, as an illustration. The 80-acre farm has to have just about as many machines as the 240-acre farm, but some of them will be smaller: a 6-foot binder instead of an 8-foot, a two-plow instead of a three-plow tractor, an 8-foot instead of a 10-foot disk harrow, and so on. The total investment for the equipment is only a little less for the 80-acre than for the 240-acre farm. The investment charge per acre, however, is more than twice as great. Furthermore, the cost for man labor on all operations will be greater per acre, because of the smaller size of the machines and the smaller amount of work done per man per day. And since both farmers receive the same prices for their products, it doesn't require much figuring to know who will have the largest income per acre at the end of the year.

But now as to the intensive methods which the small farm is to employ to offset its handicaps. Is it to be deep plowing? Deep plowing does not always, or even generally increase the yield, but assuming it did in this particular case, can't the farmer with the 240 acres and the 3-plow tractor plow just about as deep as the other? He will not be hurried in getting his plowing done on a well-organized farm of this size, if he has a good 3-plow machine, and with his more efficient size of tractor he can do the additional work at a lower cost per acre.

It is to be through the use of manure? The large farm has the advantage in justifying the purchase of a large and efficient sized spreader, while on an 80-acre farm very often the amount of manure to be handled will hardly justify the purchase of a spreader, but at best it will be a small and less efficient one.

Is it through the use of commercial fertilizers as is frequently suggested? If this is a profitable practice for the small farmer it is just as profitable for the large one. Furthermore, the large farm will buy three times as much, which may give a lower price or permit of carload freight

rates as against those rates that the smaller farm owner could obtain. When it comes to distributing it the large farm will justify the use of a large size distributor which will cover an acre for less than the smaller size on the 80-acre farm, and the investment per acre for the machine will also be lower. Is it to be through green manuring and cover crops? The large farm can practice this just as well as the small one and will have the advantage in using more efficient machinery in planting such crops and in turning them under. And so on through the list of intensive farming practices.

Good practices are not confined to the small farm and it is ridiculous that such "bunk" should be handed out to farmers to encourage them to buy modern equipment. However, comparatively few farmers will "fall" for it.

Why not say to the farmers: "You are using equipment which will permit you to crop only 100 acres. Now by getting this larger and more efficient machinery, your investment in equipment will be increased only 15 to 20 per cent, while you can till 200 acres and not work any more hours per year, and by using this improved equipment you will be able to do twice as much work per day as with that you are now using and you can care for twice as great an acreage."

Isn't that logical? And doesn't it sound better than to say to him: "Now you are using old and out-of-date equipment. We admit you are getting your work done in some fashion, but you are not up-to-date. By buying one of these large machines, like farmers use who have double your acreage, you can cut down the expense of operating your farm by several dollars, and while you won't have nearly so much for it to do as they will, you can offset this by doing better work."

Farmers Should Farm More Land And Use More Power and Labor-Saving Machinery

In one case he is told how to increase his income in the same manner that any other business depends upon increasing its income, that is, by expanding. In the other he is told to attempt to increase his income by reducing his expenses in the way of increasing his income, and few business men would care to depend entirely upon such a method, much as they try to cut down their operating expenses.

Now just stop and think. How many times did you ever see, in reading literature intended for the farmer, arguments to the effect that improved machines would permit increasing the size of the farm, and thus increase the farm income; that many farmers by buying or renting additional land could well afford to adopt larger and more modern equipment, that what the country needs is fewer farms and larger and more efficient ones, and a smaller farming population with a greater productive capacity through the more extensive use of machinery? I'll venture to say that for every time you have seen such statements, you have seen many to the effect that farmers should farm less land and do it better so as to get high yields per acre like European peasants, or bewailing the fact that people were leaving the farms for the cities and proclaiming that something ought to be done to keep the boys on the farms. Someone has very truthfully remarked that the way to keep the boy on the farm is to make farming pay, and the way to make farming pay is to have the farm large enough to use modern equipment efficiently. Surely it is not desirable that there should remain on our farms any more boys, or men either, than are necessary to produce an adequate supply of foodstuffs through the use of the most efficient equipment. The faster labor-saving machines can be adopted and the men and boys thus released engaged in other productive industries, the better it will be for all concerned.

It is not half so bad for the country to have boys replaced on farms by machines as to have them kept there doing work by old, inefficient methods that could be done better by modern machinery.

In conclusion I would like to make the following sum-

1. Wonderful progress has been made in the development of improved farm machines.
2. Much of this improved equipment is in use on only a very small percentage of our farms, even in sections where natural conditions are favorable to its use.
3. Efficiency in all industries during the coming years is highly important, but probably more so in agriculture than any other, as our farmers are likely to find themselves competing with men farming new, fertile land in other countries under favorable conditions.
4. The greatest problem which today confronts the various organizations for the promoting of agriculture is that of having available improved equipment more fully utilized.
5. There are several factors which tend to prevent the utilization of such equipment on different farms. Lack of progressiveness on the part of the farmer, while often credited with being largely responsible, is not so much so as eccentric influence and confusing advice.
6. The principal justification for the adoption of improved farm machinery is a farm of sufficient size to utilize it efficiently. This has not been emphasized in the past, but for the welfare of both the farmer and the nation it is highly desirable that it should be emphasized in the future.
7. And now, let each one of us, as deciples of good farm machinery, as good agricultural engineers ought to be, boost for the farm which is large enough to permit of the efficient use of modern equipment and where a high production per man is obtained through the use of larger machine units, the kind of a farm which is most profitable to the farmer and to the country.

Saving the Soil in Drainage

OF interest to agricultural engineers is what is called the "automatic" method of drainage, in which river lowlands, marshes, and tidal areas are drained and at the same time a good part of the soil that would otherwise be carried off in the drainage waters is saved. In this process of draining and rebuilding the soil at the same time, an ordinary dyke is thrown up along the low side of the land to keep out backwater at flood time. Corrugated iron pipes are usually run through the dyke at the natural drainage outlet, and the pipe is fitted at its lower end with a cast iron automatic gate. This gate opens outward permitting free drainage flow in normal times, but at the high flood stage the gate closes, keeping out backwater.

Pipes large enough to carry water in normal times are used. During heavy rains or melting snow they are naturally too small to carry all of the water which spreads out behind the dyke over the area being reclaimed, depositing an even layer of silt and loam washed down from the higher surrounding country. In case the natural outlet is directly into a stream, the backwater pressure from the stream completely closes the gates in high water time, producing the same result and at the same time keeping out the backwater. Thus, the area is fertilized and built up just as the lowlands along the Nile are given a new soil at flood time.

In the case of tidal marshes, the automatic gate keeps high tides from depositing additional salt, and each time the marshes are flooded from behind and then drained at low tide, a part of the salt is leached out. To hasten the process, the rear end of the pipes are often equipped with slide gates which, opened and closed by hand, serve to hold the silt-bearing water on the land, insuring complete deposit after receding waters outside the dyke have permitted the automatic gate to open.

Resurfacing has also been hastened in innumerable cases by plowing up the earth on the banks of streams or worthless hill lands draining into the area under reclamation. The results of this are obvious.

Research in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the A. S. A. E. Research Committee. Members of the Society are invited to discuss material presented, to offer suggestions for timely topics, and to prepare special articles on any phase of agricultural engineering research

Some Fundamentals of the Ventilation of Animal Shelters

By R. W. Trullinger

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THE recent development of a widespread interest in a broader knowledge of the ventilation of shelters for livestock and poultry is quite significant, especially in view of the fact that there exists a rather voluminous history of investigational work in the subject which has been conducted by state, federal, and private institutions, and foreign institutions for the past 35 or 40 years.

However, with a few exceptions, the majority of studies on the subject have, apparently of necessity, been conducted in barns, houses, and other shelters already in service. Thus the possibility of complete control of the factors influencing ventilation and of making accurate observations of the important ventilation factors corresponding to the health and comfort of the animals has been practically eliminated at the start. The tendency to install and test arbitrarily chosen systems of ventilation under the extremely variable conditions of weather and of the animals themselves, especially in the absence of suitable optimum standards for the ventilation factors, has also been a quite prevalent practice.

It is not strange, therefore, that a survey of what is known of the subject would seem to indicate that the available knowledge of fundamental principles upon which to base the development of rational and efficient ventilation systems for animal shelters is quite limited, to say the least. The matter would thus seem to merit the intelligent and serious consideration of agricultural engineers in general.

A preliminary analysis of the subject, made in view of the growing demand for information, indicates that the mere testing of preconceived types of ventilating apparatus in a comparative manner without a previous consideration of the elementary factors of ventilation involved must eventually give way to sincere attempts to determine the factors of ventilation which influence the body processes of different animals, and to so evaluate them as to tend to maintain such processes at an optimum, in order to provide a sound basis for the design and development of systems of ventilation.

Some work of this general character has been done, although much of it is fragmentary or scattered in character. It seems advisable, however, to summarize some of the higher points of the available fundamental knowledge of ventilation as influenced by the specific requirements of livestock and poultry in order to establish its status, and incidentally to suggest starting points for the further elucidation of the subject. This paper is therefore confined to a summary of the status of the necessary preliminary considerations in ventilation and will not deal with types of ventilation systems.

Air Supply and Purity for Livestock

It seems virtually self-evident that livestock require an optimum amount of oxygen supplied at an optimum rate in order to live and function at the maximum of effectiveness and economy. The Wisconsin and Maryland state agricultural experiment stations and the North of Scotland Agricultural College, for instance, found that good ventilation of dairy barns was conducive to larger milk yields from dairy cows and that low temperatures did not necessarily reduce yields as long as they were natural and constant. There was also no appreciable influence upon the quantity of food consumed. The British Board of Agriculture and Fisheries found that an abundance of fresh air at night especially had a tendency to increase not only the milk yield of dairy cows but also the fat content of the milk. The Highland and Agricultural Society of Scotland also found that free ventilation of dairy barns permitted greater milk production by dairy cows than restricted ventilation, and the general health of the cows was better.

The results of studies from other sources have also demonstrated the generally beneficial influence of free ventilation on the health, comfort, and economy of horses, beef cattle, hogs, and sheep. Thus, as common sense would dictate, the superiority of free over restricted ventilation seems well established. However, since there are other factors of the ventilation of animal shelters which must be considered and which may be influenced more or less by the air supply, or may partially govern the air supply, it would seem that something more definite should be known as to the actual optimum requirements of different animals for air.

In this connection the Wisconsin station found that in order to maintain health and comfort standards, a horse must draw into and force out of his lungs an average of 142 cubic feet of air per hour, a cow 117 cubic feet, a pig about 46 cubic feet, and a sheep about 30 cubic feet. It was estimated that the necesary degree of purity based on the carbon dioxid content of pure and expired air should be not less than 96.7 per cent. On this basis it was estimated that on an average air must enter and leave a stable at the rate of 4,303 cubic feet per hour for a horse, 3,545 cubic feet for a cow, 1,394 cubic feet for a hog, and 909 cubic feet for a sheep. However, the Pennsylvania station found, in more controlled studies, that a horse requires 2,307, a cow 2,452, a hog 767, and a sheep 332 cubic feet of air per hour. While the figures obtained for cows at the two stations agree fairly well, those for the other animals vary quite widely. For the purpose of further comparison it is interesting to note that studies at a German institution indicated that a cow should have about 1,765 cubic feet of fresh air per hour on the basis of a maximum carbon dioxid content of the air of 2.4 per cent. The discrepancies in these results seem wide enough to indicate the importance of a more controlled study of volume of respiration and optimum air requirements of these animals.

That phase of air supply and requirements which is called air purity and which is usually estimated on the basis of carbon dioxid content of the air has also received considerable attention. It seems now rather well agreed that carbon dioxid in itself is not poison. Apparently the danger of carbon dioxid in the air lies simply in the fact that it displaces a certain amount of air and therefore reduces in proportion the amount of oxygen available to the animal for breathing purposes. It is well known that an animal will suffocate almost instantly in an atmosphere of pure carbon dioxid, yet early experiments at the Minnesota station with a steer in a hermetically sealed chamber

showed that the animal could live in an atmosphere containing an alarmingly high percentage of carbon dioxid.

The problem therefore seems to have its solution in establishing once and for all the standard range of optimum oxygen requirements for different animals. It would seem that a certain amount of oxygen is needed for the best interests of each animal, regardless of how much carbon dioxid is given off or is already present in the air. Once the figures are also established for the carbon dioxid contents of fresh and respired air, the matter of necessary air supply per unit time would seem to be one of an exercise of simple mathematics.

In this connection determinations of the carbon dioxid content of the air in the dairy barn at the New Hampshire station showed that the percentages existing at regular intervals during the day and night at fifteen different locations in the front and rear of the animals varied from 0.228 to 0.089. On the other hand, the percentages found by the 1918 Committee on Farm Building Ventilation of the American Society of Agricultural Engineers, in studies of five barns, ranged as high as 1.231, although they were for the most part not higher than from 0.2 to 0.3. The Wisconsin station found that the permissible percentage of carbon dioxid in the air of livestock shelters is 0.167 by volume, and the Pennsylvania station concluded that the actual carbon dioxid production is the proper basis upon which to estimate the rate of ventilation required. The importance of studies under controlled conditions to determine proper carbon dioxid limits to correspond to the optimum health conditions of livestock seems thus plainly evident.

Air Supply and Purity for Poultry

The question of amount and purity of air required by poultry would not seem to be fundamentally different from that for livestock. Poultry apparently require a certain amount of oxygen per unit of time for optimum health and productiveness, and the fact that they emit a certain amount of carbon dioxid during respiration, thus reducing the volume of air available to them at a given moment, indicates the importance of also learning what the proper balance between carbon dioxid and fresh air for them should be.

In this connection the Southeast Agricultural College in England found that chickens breathe about one pint of air per minute or 1.2 cubic feet per hour. Older chickens were found to breathe more air at each respiration than the younger ones but to breathe more slowly. The air requirement of a medium bird weighing about 4.5 pounds seemed to be much the same as that of a larger bird weighing 7.5 pounds. Further studies showed that while poultry were apparently healthy in the presence of from 6 to 8 volumes of carbon dioxid in 10,000 volumes of air, 9 volumes of carbon dioxid was the maximum permissible content. From this it was estimated that each bird would require 40 cubic feet of air per hour to provide a satisfactory factor of safety to prevent exceeding this limit of purity. Other studies have indicated that variations in climatic conditions and in breed of bird may materially influence these factors.

However, the Canada Experimental Farms showed that free ventilation of poultry houses is superior to restricted ventilation. In an extreme case it was found that the chicks from the eggs of hens which had voluntary run during the winter were strong and lived, while those from the eggs of hens kept closely confined died.

Apparently few other data are available on the requirements of poultry as regards the supply and purity of the air. It would seem that controlled studies of these ventilation factors for poultry of different breeds and under different climatic conditions are of as much importance as similar studies for livestock.

Temperature and Humidity of Air In Livestock Shelters

Where natural systems of ventilation are used, the heat given off by the bodies of livestock is relied upon to maintain the temperature of shelters at a comfortable degree, especially in cold weather. It therefore also serves as the primary motive power for ventilation of the shelters.

However, everything indicates that there is a certain range of temperature in shelters which corresponds to the optimum of health, comfort, productiveness, and economy in each kind of livestock. The Pennsylvania station showed, for instance, that the bodies of livestock during health maintain a nearly constant temperature. While the external temperature tends to influence the outflow of bodily heat, the animal is able to regulate it by physical and chemical methods, but there is a certain critical external temperature at which the outflow of heat just balances the necessary heat production of the animal as a result of internal work. Above this temperature the radiating capacity of the body surface varies to meet the varying conditions; below it the oxidation of tissue is required to

Careful consideration of the proper requirements for the ventilation of animal shelters is one of the most important essentials in present day designing and equipping of farm buildings

maintain the normal temperature of the body. Thus temperature appears to have a double significance in that it induces the air movement of ventilation and that it influences feed consumption, productive feeding, and animal comfort.

In this connection the Wisconsin station found a difference of 6.3 degrees F. in the mean temperature of a dairy stable during periods of good and poor ventilation, and that the cows drank more water during the latter periods. The Massachusetts station found that the apparent influence of a warm stable upon milk and butterfat production by six cows was small, although on the average more milk and butterfat was produced in the warm stable. In two trials with 12 cows and two with 6 cows to compare the effect of a stable temperature of about 55 degrees F. with that of a temperature of 45 degrees F. upon the milk yield, the Wisconsin station found that on the average the results of all the trials were in favor of the higher temperature. The Durham Agricultural College in England found that when cows were exposed to cold weather the fat content of their milk was considerably lowered. On the other hand, the North of Scotland Agricultural College found, in experiments with 104 cows, that any restriction of the ventilation of the dairy stable sufficient to bring the temperature up to 60 degrees F. led to a degree of atmospheric impurity inconsistent with the conditions of perfect health. In stables in which the temperatures were kept down by thorough ventilation, the cows did not suffer either in health or milk yield even from very low temperatures in winter. Whatever waste of food was entailed in the maintenance of the body heat of cows in colder stalls was more than counteracted by the influence of fresher air. It was considered apparent that the temperature of cow stalls should not go above 50 degrees F., especially in the autumn and early winter.

It is even more interesting to note that German experiments showed that a cow contributes only about 20,000 heat units daily to the warming of a stall and that the minimum permissible temperature in a cow stall is from 62.6 to 64.4 degrees F. The limiting temperature below which the animal heat is insufficient to maintain a desired temperature was found to be 32 degrees F. when the air in the cow stall was changed completely from one to one and one-half times daily. It was therefore found necessary at the lower temperature to so regulate the ventilating apparatus as to limit the air addition to below the desired amount. The provision of artifical heat for dairy cow stalls under such conditions seemed advisable. Further experiments with horses showed that the maintenance of too low a stall temperature increased the amount of food required. An average stall temperature for work horses of 59 degrees F. and from 63 to 66 degrees F. for colts was found desirable for the cold part of the year. English experiments on the effect of change of temperature on the basal metabolism of swine showed that, as the environmental temperature decreased below the critical temperature, which was established at 69.8 degrees F., the metabolism of the pig increased at the rate of approximately 4 per cent per degree.

The 1920 Committee on Farm Building Ventilation of the American Society of Agricultural Engineers found, in studies of climatic dairy barns, that dairy barn temperatures may vary from 35 to 50 degrees F. according to the climatic zone, but that they should never go below 35 degrees F. It was also found that the amount of heat given off by a dairy herd is very nearly constant for cattle of a given size for a given climate.

The Pennsylvania station established definite relations between the heat produced and carbon dioxid eliminated by cattle. A comparison of the daily output of carbon dioxid and the heat production by steers and cows for 188 different days showed that in each case the ratio of the carbon dioxid produced in grams to the total heat emission in calories was very close to 0.4. It was further shown that, since the higher the temperature of the air the greater is its moisture-holding capacity, the motive power for ventilation derived from water vapor is of only secondary importance. In addition, it was shown that cows, horses, hogs, and sheep of respective average live weights of 1,075, 1,250, 280, and 91 pounds will maintain respective average temperature differences, corresponding to air flows computed from carbon dioxid production, of 36.58, 36.49, 36.4, and 36.5 degrees F. It is interesting to note in this connection that the Wisconsin station found that these respective temperature differences were 35.6, 19.6, 20, and 13.3 degrees F.

The Pennsylvania station further found that when the standards for air flow for different animals as established by the Wisconsin station are taken as the minimum, the heat supplied by cows appears to become deficient for maintaining what is believed to be the best stable temperature when the outside temperature is below 15 degrees F. The heat supplied by horses, hogs, and sheep appeared to become deficient at a much higher outside temperature. However, when rate of air flow computed from the carbon dioxid production was made the basis, the difference between the animal species disappeared. Experiments on the maximum ventilation compatible with the maintenance of a given temperature difference indicated the necessity in severe weather of restricting the ventilation in order to conserve heat and maintain a desirable stable temperature. This resulted in lowering the purity of the stable air below the standard set by the Wisconsin station. Thus, in spite of the apparent fact that the carbon dioxid produced by animals is approximately proportional to their heat production, it would seem that the at present accepted ventilation requirements for different animals are not proportional to their heat production.

Respiration calorimetric experiments on warm blooded animals by a private institution showed that with fasting animals the ratio of heat production to body weight was quite constant for animals which were more than one-third grown. In the case of smaller animals the heat production per gram rose rapidly as the animals decreased in weight. Animals kept together in twos and threes showed a smaller heat production per gram of body weight than when they were kept separately.

The Massachusetts and Pennsylvania stations introduced another interesting but complicating factor by showing that different breeds of dairy cows present different conditions to be met with reference to the maintenance of proper temperatures. The former station considered it reasonable to expect Holsteins, for instance, to maintain, in zero weather, a temperature above freezing in a given stable and at the same time to maintain adequate ventilation conditions. On the other hand, it was shown that when Jerseys in low production were housed in the same stable with the same air flow, the temperature dropped below the comfortable point. It was therefore necessary to so reduce the air flow as to lower the ventilation standard considerably in order to maintain the proper temperatures.

The number and importance of the factors entering into the maintenance of a proper balance between temperatures and air supply in livestock shelters are thus plainly evident. The disagreement in many cases between investigators as to standard ranges of optimum temperatures for different animals is also evident. The need for further fundamental and controlled investigation of the temperature and air purity requirements of cattle, horses, sheep, and hogs as a basis for the development of rational ventilation systems seems thus clearly evident.

Temperature and Humidity of Air in Poultry Houses

The situation as regards temperature requirements of poultry would again seem to be not fundamentally different from that for livestock, except that even less well-established information of a tangible nature is available.

The North Dakota station showed in feeding experiments with 46 chickens that when the poultry house was heated about half as much food was consumed and the egg production was more than doubled. Two years of experiments at the West Virginia station with floored and unfloored poultry houses showed that the fowls remained in as healthy a condition and laid as many or more eggs in the somewhat warmer unfloored houses than in the floored houses. The Montana station found that poultry

houses could be profitably heated to an average temperature of from 45 to 50 degrees F. The latter temperature being regarded as the most satisfactory.

In contrast to these results, the Michigan station found, in two years' studies with three flocks of 70 White Leghorn hens, that beyond comfort to the birds there was nothing to be gained in egg production by the construction of warmer poultry houses. The Canada Experimental Farms found that hens kept in unheated poultry houses laid more eggs than when kept in heated houses. Similar results were obtained at the Ontario Agricultural College and at the Maryland station. The latter institution found that the general health of the fowls kept in warm and cold houses was practically the same during a period of two years, except that the lack of fresh air and the excessive moisture in the warm tight house caused an absence of bright red combs and the appearance of rough and dirty plumage. The plumage of the fowls in the colder but better ventilated and dried houses was bright and clean. The Southeast Agricultural College in England found that floored poultry houses permitting ground ventilation gave better results as regards egg production than unfloored houses. The temperatures of the two types of houses and the carbon dioxid content of the air were the same, but the quantity of heat lost by the birds was greater in the floorless house.

These results show how investigators disagree regarding the temperature requirements of poultry, and would therefore seem to indicate a need for a study of this factor influencing ventilation under absolutely controlled conditions.

Discussion

As a whole this brief history of the study of some of the fundamentals of animal shelter ventilation seems to indicate that the primary purposes of the ventilation of such shelters are to supply sufficient fresh air and to maintain such degrees of air purity, temperature, humidity, and exposure to drafts, as will tend to promote the existence of optimum conditions in the animal concerned as regards health, comfort, economy, and productiveness.

Unfortunately the standards by which the condition of the animal concerned have heretofore been judged with reference to health, comfort, economy, and productiveness are difficult to recognize in many cases and in others apparently no standards of this nature have been considered at all. Everything therefore seems to indicate the importance of basing judgment as to the condition of the animal concerned upon expert observations of such factors as weight, body temperature, blood circulation, respiration and metabolism, rate of growth, activity, food and water consumption, and apparent comfort, in addition to egg and meat production and quality in the case of poultry, milk production and quality in the case of dairy cows, and meat and hide production and quality in the case of beef cattle, hogs, and sheep. The maintenance at an optimum of some such set of physiological characteristics of the animal concerned is obviously the justification for as well as the basis of ventilation, and the importance of sincere attempts to so evaluate the factors of ventilation as to maintain such characteristics at an optimum as a basis for the development of ventilation systems would seem to be quite evident.

This general procedure is now being adopted by several institutions. A striking example of this is the method of procedure being planned by the Iowa station in studies of poultry house ventilation. The proposed procedure involves the use of hermetically sealed poultry pens which will permit the accurate and practically absolute control of ventilation factors and their ultimate evaluation to correspond to optimum health and comfort conditions of the poultry, as indicated by the factors enumerated above. The amounts and rates of ventilation corresponding to the optimum values of the ventilation factors can thus be determined for Iowa conditions and ventilation systems designed accordingly.

Similarly the Pennsylvania station has attempted to control the studies of the health and comfort requirements of livestock and of the corresponding ventilation factors by the use of a respiration calorimeter. It has been possible by this means to study accurately heat and food values, with particular reference to the nature, amount, and rate at which heat is produced by the animal body, and some of the most recent and apparently fairly reliable data on the relations of heat production, air purity, humidity, and natural ventilation motivation with reference to livestock have been deduced.

Several other institutions in this country and in Europe, particularly in Germany and England, are adopting the use of respiration calorimeters for preliminary studies of animal ventilation. The importance of this precedure would seem to be clearly indicated by such use.

Regardless of how learnedly we may discourse upon the ratio between this and that ventilation factor or of the relative merits of this and that ventilation system, the fact remains that livestock and poultry require a certain amount of oxygen and a certain amount of warmth to permit them to live comfortably and function efficiently and economically. The obvious purpose of a natural ventilation system where no artificial heat is used is to supply the animal concerned with the amount of oxygen he requires at the proper rate and at the same time to permit him to keep himself properly warmed. Since the animal tends to dilute or in effect reduce his available oxygen supply during a given period of time by expelling carbon dioxid and at the same time supply his own heat, the problem would seem to be to establish as nearly as possible an optimum balance between practical amount of ventilation, air supply required, warmth required, heat production, and air dilution or displacement by carbon dioxid to correspond to the optimum conditions of health, comfort, economy, and productiveness for each species of farm animal under each specific range of conditions, including variable heat transmission characteristics of different building materials and types of construction. The available information indicates that under certain conditions of low temperature, severe climate, or types of available structure this is quite difficult to do, it being sometimes necessary to make a sacrifice either of air purity or of warmth in order to maintain a practical balance of ventilation factors, economical construction, and physiological characteristics of the animal. This makes it all the more evident that the results of ventilation studies can be of no more than speculative accuracy unless they have been conducted under controlled conditions with animals the health, comfort, economy, and productiveness values of which are known with a reasonable degree of accuracy as judged by suitable standards. This would seem to emphasize the necessity of close cooperation between the agricultural engineer and animal husbandman in such work and the employment of methods and apparatus similar to those used in respiration calorimetric studies to provide the proper bases for the design of ventilation systems.

In accordance with the findings of the Committee on Farm Building Ventilation of the American Society of Agricultural Engineers, such studies should be sufficiently fundamental and controlled as to ascertain with certainty what constitutes good ventilation, what equipment will supply such ventilation under specific conditions, and how it may be properly controlled.

References

Armsby, H. P., and Kriss, M.—Some fundamentals of stable ventilation. Jour. Agr. Research [U. S.]. 21 (1921), pp. 343-368.

Armsby, H. P.—The respiration calorimeter at the Pennsylvania station. Experiment Station Record, 15 (1903-04), pp. 1037-1050.

Armsby, H. P.—Heat values and food values. Arch. Ped., 22 (1905), Feb., pp. 124-130.

Armsby, H. P.—The respiration calorimeter at the Institute of Animal Nutrition of the Pennsylvania State College. Pennsylvania Sta. Bul. 104. 1910.

Armsby, H. P., et al.—The carbon dioxid: heat ratio in cattle. Natl. Acad. Sci. Proc., 6 (1920), pp. 263-265.

Benedict, F. G., et al.—A respiration chamber for large domestic animals. New Hampshire Sta. Tech. Bul. 16 (1920).

Brooks, W. P.,—Experiment in warming a stable for cows. Massachusetts Hatch Sta. Rpt. 1895, p. 205.

Buckley, S. S.—Tuberculosis of animals. Maryland Sta. Bul. 145. 1910.

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Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Electrical House Pumping Systems. G. C. Blalock and D. D. Ewing. (Purdue University, Lafayette Engineering Extension Service Bulletin 4 (1923), pp. 30, figs. 6.) The object of this publication is to prevent pertinent information concerning the various electric motor driven water supply systems now on the market in such a manner as to permit their intelligent selection and applica- is also included. Data from operating records and tests of several systems are appended.

Tests Show how Damp Sand Curing Improves Quality of Concrete. F. D. Crook and H. Faulkner. (Engineering News-Record, New York, 92 (1924), No. 25, pp. 1050, 1051, figs. 4.) Laboratory tests of concrete mixtures to determine the influence of crank case oil on the strength of road concrete showed that air cured specimens completely saturated with the oil possessed low compressive strengths, whereas damp sand cured specimens showed only the slightest surface penetration and posessed high compressive strengths. The conclusion is drawn that oil drippings are harmless to well made concrete.

It was further found that air cured specimens were reduced to one-half their original weight after immersion for four days in a 10 per cent solution of hydrochloric acid, while damp sand cured specimens showed only a slight surface attack. Permeability and abrasion tests also emphasized the fact that damp sand curing improves the quality of concrete.

An Electrical Method for the Reduction of Draught in Plowing. E. M. Crowther and W. B. Haines. (Journal Agricultural Science, [England], Cambridge 14 (1924), No. 2, pp. 221-231, figs. 6.) Studies conducted at the Rothamsted Experimental Station are reported, the purpose of which was to develop a simple electrical method for the reduction of the friction between plow moldboards and the soil. The method developed depends upon the phenomenon of electrendosmose which is exhibited by moist soil. By virtue of the negative charge of the soil colloids, water will move through moist soil toward the negative electrode under the action of an electric current. It was found that if a current was passed through the soil having the moldboard of a plow as the negative electrode, the film of water formed at the soil-metal surface acted as a lubricant and reduced the plowing draft.

Striking reductions in friction were obtained in laboratory experiments with a metallic slider moving over moist soil. Field tests demonstrated that the draft of a plow could be reduced by applying a current between the colter and the moldboard. The magnitude of the reduction obtained with this arrangement was too small to have an immediate practical value, but the method is considered to have possibilities.

Water in Crankcase Oils. A. L. Clayden. (Jour. Soc. Automotive Engin., New York 15 (1924), No. 1, pp. 47-50, figs. 3). The three ways in which water may reach the oil pan of an internal combustion engine are described, and it is stated that the danger point for water accumulation is reached where an emulsion becomes too highly viscous or when an accumulation of free water reaches the pump intake.

An emulsion of oil with water up to 5 or 6 per cent was found to differ hardly at all from the pure oil so far as film forming and lubricating qualities were concerned. On the other hand, with an oil that was absolutely nonemulsifying the tendency was for the water to segregate and collect in comparatively large globules. The ability of an oil to absorb a small percentage of water had the advantage of minimizing the danger of complete failure of oil circulation when starting in cold weather and of reducing somewhat the rate of piston ring and cylinder wall wear.

Further experiments showed that the rate of deposition of water in the cylinder oil may be indicated by a straight line graph between 35 and 110 degrees Fahrenheit, the deposition ceasing at the latter temperature. When continued below 35 degrees in the same straight line, the graph shows that at zero degrees the rate of deposition would be 80 cubic centimeters per hour.

Imhoff Tanks—Reasons for Differences in Behavior. H. P. Eddy. (American Society Civil Engineers Proceedings 50 (1924), No. 5, [pt. 3], pp. 616-645, figs. 3.) Studies are reported to ascertain the reasons for the differences in operating results obtained from Imhoff tanks in order that the requirements for satisfactory results may be better understood.

The results showed that the mineral and heavy relatively stable organic matter of combined sewage may tend to prevent the formation of excessive scum and foam, and that coarse and uncomminuted solids are probably important factors in the excessive formation of scum. It was found that where the water supply is hard the insoluble soaps formed constitute a substantial increment in the suspended solids of the sewage and may favor the formation of foam and scum. The variation in the quantity of suspended solids to be removed from different sewages was found to be so great that the design of the digestion compartment should be based on the quantity of solids to be deposited in it, rather than on a general assumption of a definite number of cubic feet per capita.

Temperature is a factor of fundamental importance in the digestion process. The required capacity of the digestion compartment is governed largely by the available temperature and by the duration of the period of low temperature. It is concluded that difficulties will be minimized by drawing sludge as early in the spring as inoffensive material can be obtained, by continuing the drawing at a rate sufficient to provide as small an accumulation in the sludge compartment as practicable during hot weather and by removing all sludge except that required for seeding before cold weather.

Fine screening was found to reduce the load on the digestion compartment and to reduce scum formation. It appeared important to distribute the deposited solids as uniformly as possible throughout the digestion compartment, indicating the advantage of a relatively short tank.

Digestion compartments should be subdivided as little as practicable, and liberal opportunity should be afforded the sludge to spread uniformly from one end of the tank to the other. Frequent reversal of flow is necessary for the successful operation of multiple compartment tanks, and it is important to obtain nearly equal distribution of solids among the several tanks.

There appeared to be a decided advantage in greater depth of tanks in preventing excessive scum formation and in providing sludge with a comparatively large proportion of solids. It was found that in the design of this digestion compartment consideration should be given to the probable density and corresponding volume of the sludge as it will lie in the tank.

A list of needs for research is presented, which includes, among other things, the kind and functions of the organisms predominating in the sludge and scum compartments.

Selecting Wall Stacks Scientifically for Gravity Warm Air Heating Systems. V. S. Day. (Jour. Amer. Soc. Heating and Ventilating Engin., Easton, Pa. 30 (1924), No. 5, pp. 391-394, figs. 2.) Data from studies conducted at the University of Illinois are presented, showing the heating effect obtainable at the registers of warm air heating systems for a variety of stack areas and register air temperatures, and on the velocities of flow actually obtaining in the stacks of gravity warm air furnace installations.

Electricity in Dairy Factories. C. Vowell. (New Zealand Journal of Agriculture, Wellington 27 (1923), No. 5, pp. 310-314.) Experiments on the use of electricity in dairies in New Zealand are briefly reported, the results of which demonstrated that dairy factories in Southland can not afford to use steam where electricity is available at reasonable rates. The electrical energy was found to be especially economical in the operation of separators.

Further experiments showed, however, that it is only by careful and scientific installation of motors of the correct power, specially designed for the particular machine they are to drive, that the maximum economy may be obtained. Collective driving by electricity, that is, driving the whole factory by one large motor is comparatively inefficient. Electricity for heating purposes in dairy factories does not show up to the same advantage as it does for power.

Experimental Study of Air Lift Pumps and Application of Results to Design. C. N. Ward and L. H. Kessler. (Wisconsin University Bulletin. Madison Engineering Series 9 (1924), No. 4, pp. 166, pls. 3, figs. 57.) Laboratory studies begun in 1919 on air lift pumps are reported.

The results showed that the efficiency of an air lift pump depends primarily upon the conditions of flow in the eduction pipe. Great refinement in the design of foot pieces, small air openings for dividing the air into fine bubbles, and special devices for mixing the air with the water were found to be unnecessary. There should be no central nozzle or projecting part to obstruct the flow of water in the foot piece. It was found that the smaller the pump in a given well the narrower will be the range of rate of pumping in which high efficiencies may be obtained.

The submergence required for maximum efficiency ranged from 65 to 75 per cent in most cases, the lower range being approached in wells with a high delivery head. Very small pumps gave relatively high efficiencies with low submergences, a 1-inch pump showing good efficiency at a submergence as low as 45 per cent. It is considered possible for this reason that the air lift pump may be satisfactorily adapted to the pumping of small wells such as are used for rural water supplies.

The combined friction and slip losses due to the flow in eduction pipes were found to follow a different law than that governing the flow of water or air in a pipe. There was a comparatively simple relation between frictional losses and velocity of flow in an eduction pipe for any particular mixture of air and water. At a given velocity of flow in a given eduction pipe the losses increased as the ratio of volume of air to volume of water increased.

There was found to be a particular velocity of flow for any ratio of volume of air to volume of water which is accompanied by a minimum loss of head. The losses increased very rapidly

when the average velocity was reduced below the above velocity. The rate of increase of losses with increase of velocity was found to depend upon the diameter of the eduction pipe. It was possible to use relatively high velocities in large eduction pipes, but in small pipes the losses increased rapidly with an increase of velocity above that giving maximum efficiency.

It was found necessary to make smooth joints in eduction pipes and to change from one size of pipe to another very gradually. Sudden enlargements were detrimental to efficient operation, and a horizontal travel of a mixture of air and water resulted in a separation of the air from the water. This is taken to indicate that eduction pipes should always be vertical.

Methods of design and testing are discussed.

[Agricultural Engineering Studies at the Wisconsin Station]. (Wisconsin Station Bulletin, Madison 362 (1924), pp. 64-69, figs. 2.) Studies by F. W. Duffee are said to have shown that greater economy results from running silage cutters at a lower speed than that commonly recommended. This is especially true of the larger machines. With smaller machines the capacity is more often the limiting factor, and more corn can be put through them by operating at a higher speed within the usual limit, but with these machines as with the larger ones the efficiency is much greater at slower speeds. There was an extreme fluctuation in power requirements at the higher speeds. At slower speeds the peak loads did not go nearly so high and the pull was more uniform and steady. The same applied in general to the elevation of silage by blowing.

Some Fundamentals of the Ventilation of Animal Shelters

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Capstick, J. W., and Wood, T. B.—The effect of change of temperature on the basal metabolism of swine. Jour. Agr. Sci. [England], 12 (1922), No. 3, pp. 257-268.

Carlyle, W. L.—Description of the new dairy and stock-judging building. Wisconsin Sta. Rpt. 1898, pp. 269-282.

Clarkson, W. B., and Witnah, C. S.—Climatic dairy barns. Agr. Engin., 1 (1920), pp. 23-26.

Douglas, C.—Influence of temperature on milk yield—ventilation of cow byres. Highland and Agr. Soc. Scotland Trans., 5 ser., 23 (1911), pp. 170-189.

Foulkes, P. H.—Experiment on the housing of milk cows in autumn. Br. Agr. and Fisheries [London] Ann. Rpt. Agr. Education and Research, 1903-04, pp. 101-103.

Gilbert, A. G.—Effect of close confinement on poultry as compared with fresh air. Canada Expt. Farms Rpt. 1902, pp. 203-216.

Gilbert, A. G.—Warm vs. cold poultry houses. Canada Expt. Farms Rpt. 1906, pp 257-272.

Gilchrist, D. A., et al.—Variations in the composition of milk and their probable causes. County Councils Cumberland, Durham, and Northumberland, Agr. Dept. Durham Col. Sci. Rpt. 12 (1903), pp. 54-75.

Hagermann, O.—The respiration calorimeter in Boon and some investigations with two oxen and one horse. Landw. Jahrb., 41 (1911), Erganzungsb. 1, pp. 438.

Harcourt, R., and Graham, W. R.—Poultry house experiments. Ann. Rpt. Ontario Agr. Col. and Expt. Farm, 34 (1908), pp. 77-79' 164-169.

Hendry, M. F., and Johnson, A.—Carbon dioxid content of barn air. Jour. Agr. Research [U. S.], 20 (1920), pp. 405-408.

Hill, A. V., and A. M.—Calorimetrical experiments on warm blooded animals. Jour. Physiology, 46 (1913), No. 2, pp. 81-103.

Hinebauch, T. D.—Feeding experiments with chickens. North Dakota Sta Rpt. 1896, pp. 16-18.

Jordan, W. H.—The King system of stable ventilation. New York State Sta. Circ. 7, 1906.

Kempster, H. L.—Comparison of warm v. cold houses as regards egg production. Mich. Acad. Sci. Rpt., 12 (1910), pp. 85, 86.

King, F. H.—A preliminary experiment on the influence of imperfect ventilation upon milch cows. Wisconsin Sta. Rpt. 1891, pp. 61-68.

King, F. H.—Ventilation for dwellings, rural schools, and stables. Madison, Wis.: Author, 1908.

Knoch, R.—Ventilation of cattle barns. Kuhn Arch., 5 (1914), pp. 289-308.

Ludewig.—The significance of circulation of air in stalls. Arch. Wiss. u- Pratk Tierheilk., 36 (1910), Sup. pp. 299-305.

Mackenzie, K. J. J., and Russell, E. J.—The amount of air space required in poultry houses. Jour. Southeast. Agr. Col., Wye, 1904, No. 13, pp. 84-102.

Mackenzie, K. J. J., and Russell, E. J.—Ventilation of poultry houses. Highland and Agr. Soc. Scot. Trans., 5. Ser., 20 (1908), pp. 87-100.

Opperman, C. L.—Poultry house construction and its influence on the domestic fowl. Maryland Sta. Bul. 146. 1910.

Pinkemeyer, W.—Stable ventilation and ventilation of rural dwellings. Landw. Ztschr. Rheinprovinz 14 (1913), No. 45, Sup., pp. 8.

Richards, W. B., and Jordan, E. L.—The effect of different stable temperatures upon the milk yield of dairy cows. Wisconsin Sta. Rpt. 1904, pp. 143-148.

Robinson, T. R., and Russell, E. J.—Relative efficiency of poultry houses with and without ground ventilation. Jour. Southeast Agr. Col. Wye, 1905, No. 14, pp. 175-186.

Spier, J.—Influence of temperature on milk yield. Highland and Agr. Soc. Scot. Trans., 5. ser., 21 (1909), pp. 255-306.

Stewart, J. H., and Atwood, H.—Poultry experiments. West Virginia Sta. Bul. 60 (1899), pp. 50-63.

American Soc. Agr. Engin. Trans., 12 (1918), pp. 282-306.

Montana Sta. Rpt. 1902, pp. 96-100.

News Section

PROGRAM

Meeting of Farm Power and Machinery Division of American Society of Agricultural Engineers Great Northern Hotel, Chicago December 3, 1924

Morning Session

9:30 A. M.	Meeting called to order by Vice-President O. B. Zimmerman
9:35 A. M.	Report: "1924 Silo Filler Tests", by F. W. Duffee, University of Wisconsin
10:00 A. M.	Discussion
10:30 A. M.	Paper: "Grain Cleaners in Heavy Dockage Areas", by Robert H. Black, division of grain cleaning investigations, U. S. Department of Agriculture
10:45 A. M.	Discussion
11:20 A. M.	Paper: "Design of Soil Handling Machinery", by Theo Brown, chief experimental engineer, Deere & Company
11:45 A. M.	Discussion
12:30 P. M.	Luncheon and Good Fellowship Get-Together

Afternoon Session

2:00 P. M.	Paper: "The Combined Harvester-Thresher —Its Development and Future Possibilities". W. F. Mac Gregor, engineer, J. I. Case T. M. Company.
2:30 A. M.	Discussion
2:50 A. M.	Paper: "Rating of Farm Tractors".
3:00 P. M.	Discussion
3:30 P. M.	Paper: "The Menace of Foreign Agricultural Competition and Its Agricultural Engineering Aspects", by A. P. Yerkes, editor "Tractor Farming," International Harvester Company
4:00 P. M.	Discussion

(The above papers will be discussed by agricultural engineers from the farm-equipment industry, the state agricultural colleges and federal department of agriculture, and by others who may wish to participate in the discussions. The discussions are open to non-members as well as members of the American Society of Agricultural Engineers, and anyone interested in any particular subject on the program is invited to contribute to the discussion that follows.)

N. A. F. E. M. Commends Society

THE following significant resolution adopted at the thirty-first convention of the National Association of Farm Equipment Manufacturers held in Chicago, October 22, 23, and 24, will be of special interest to members of the American Society of Agricultural Engineers:

"Resolved, that this Association commend the activities of the American Society of Agricultural Engineers and request its membership to cooperate with this society whenever requested and it is practicable to do so."

This convention was addressed by President H. B. Walker on the subject of the relation of agricultural engineer and land grant colleges to the farm-equipment industry. President Walker paid high tribute to the important part taken by modern farm machinery in the development of agriculture in this country.

Supplementing the address of President Walker, R. B. Lourie, of Deere & Company, chairman of the N. A. F. E. M. committee on cooperative relations between agricultural engineers and the farm-equipment industry, spoke at considerable length on the possibilities for cooperative work with agricultural engineers through the Society. He covered all lines of contact, including tractor service schools, investigational projects, Smith-Hughes schools, dealer convention speakers, apprenticeship training and vacation em-

ployment of agricultural-engineering students, etc. Mr. Lourie paid a very high tribute to the Society and made a very forceful talk on the exceptional opportunity which is offered the farm-equipment industry through closer cooperation with agricultural engineers.

The election of officers of the Association resulted in the choice for president of Finley P. Mount, president of the Advance-Rumely Company, and for chairman of the executive committee of E. J. Gittens, vice-president of the J. I. Case Threshing Machine Company.

Meeting of Joint Committees on Cooperative Relations

A MEETING of the joint committees on cooperative relations of the American Society of Agricultural Engineers and the National Association of Farm Equipment Manufacturers, presided over by President Walker of the Society, was held at the Auditorium Hotel, Chicago, October 22, during the thirty-first annual convention of the N. A. F. E. M. The members of the N. A. F. E. M. committee present included R. B. Lourie, of John Deere Plow Company, chairman; H. W. Hirschheimer, LaCrosse Plow Company; George W. Iverson, Advance-Rumely Company; A. P. Yerkes, International Harvester Company; Dave Darrah, Hart-Parr Company; and F. A. Wirt, J. I. Case Threshing Machine Company. The members of the A. S. A. E. committee, which is a committee of the College Division of the Society, included H. B. Walker, Kansas State Agricultural College, chairman; J. B. Davidson, Iowa State College; O. W. Sjogren, University of Nebraska. Others present included Raymond Olney, secretary of the A. S. A. E.; S. H. McCrory, U. S. Department of Agriculture; F. W. Duffee, University of Wisconsin; and Mr. Wilson, of John Deere Plow Company.

The committee is giving a great deal of attention to ways and means by which agricultural engineers and the farm-equipment industry may be of greater service to Smith-Hughes teachers of vocational agriculture in secondary schools. A report of what the committee is doing in this direction was made by F. A. Wirt. One of the big problems from the standpoint of the farm-equipment industry is to get dealers and sales forces educated to the possibilities of close cooperation with Smith-Hughes teachers. A specific example of what might be done along this line was given by Mr. Lourie, in which a local plowing contest was arranged by a Smith-Hughes instructor in Illinois and in connection with which the John Deere Plow Company furnished a cup for the prize winner in the contest; the local dealer was intensely interested and took an active part in making the demonstration a success.

In this connection it was suggested that standard rules and regulations be prepared for such plowing contests to be staged by Smith-Hughes instructors in cooperation with local farm-equipment dealers, and in addition it was further suggested that state plowing contests might be arranged with winners in local communities as entrants. A committee consisting of Messrs. Yerkes, Davidson, Sjogren, and Wirt were empowered to make a study of such a program, with the understanding that the contest provided for in such a plan be limited entirely to amateurs and school boys.

A report on local tractor short-course schools, which was previously approved by the N. A. F. E. M. committee, was presented at the meeting and as soon as the A. S. A. E. committee has had an opportunity to review the report and make suggestions, the outline for the schools will be revised and sent out to committee members of both organizations for further suggestions.

The importance of extensive research work in the farm-equipment field was discussed at the meeting. Considerable discussion was given to specific research problems. Copies of a list of research projects was discussed and it was planned to have definite projects undertaken in different states.

In connection with the discussion of trainee courses for agricultural engineering graduates in farm-equipment manufacturing plants, Mr. Lourie stated that Deere & Company were definitely committed to taking ten graduates each year and providing summer employment for twenty undergraduates. A training course has also been started by J. I. Case Threshing Machine Company. This subject created some very interesting and constructive discussion.

Wooden Sleeping Car Resolution Approved

AT a meeting of the administrative board of American Engineering Council in Chicago October 17 and 18, the resolution submitted by the American Society of Agricultural Engineers relating to the use of wooden sleeping cars, published in the September issue of AGRICULTURAL ENGINEERING, was approved and the Board authorized the executive secretary, L. W. Wallace, to take up the matter with the Interstate Commerce Commission.

As announced in the October issue of AGRICULTURAL ENGINEERING, the Interstate Commerce Commission had previously recommended to Congress that the use in passenger trains of wooden sleeping cars between or in front of steel cars be prohibited, and it is hoped that with the organization representing engineering societies behind the recommendation, Congress will take action at an early date to prohibit this deplorable practice.

Report of Meeting of A. E. C. Administrative Board

A MEETING of the Administrative Board of American Engineering Council was held at the headquarters of the Western Society of Engineers, Chicago, October 17 and 18.

One of the most important actions taken by the Board at this meeting was the resolution to return to the plan of government reorganization embodied in the Jones-Reavis Bill originally sponsored by the engineering profession. The A. E. C. committee on government reorganization as relating to engineering matters was instructed to adopt a policy of aggressively working for the complete project of a department of public works as outlined several years ago. The committee will work with other organizations in allied fields and submit a comprehensive report at the annual meeting of the Council to be held in Washington, January 16 and 17, 1925.

The Board discussed at some length the question of reclamation and adopted a resolution carrying out the recommendations of the executive secretary, L. W. Wallace, that a special committee on reclamation be appointed to study the question for the purpose of formulating a course of procedure for American Engineering Council and pursuing such a course when and if approved. This recommendation was with special relation to the report made by the special advisory committee appointed by the Secretary of the Interior Work to make a study of the Bureau of Reclamation. It is proposed that a special committee of American Engineering Council study the report and the proposed legislation for the purpose of determining what line of action, if any, the American Engineering Council will pursue with relation to the matter.

The Board voted its opposition to the Cramton Bill, which would place the control of industrial alcohol in the hands of the Prohibition Unit. The Council thus supports the position taken by the American Chemical Society and the American Institute of Chemical Engineers.

The Board voted to send the Interstate Commerce Commission, with its approval, the resolution submitted by the American Society of Agricultural Engineers regarding the use of wooden sleeping cars in connection with steel ones, which was published on page 211 of the September issue of AGRICULTURAL ENGINEERING.

Appointment of engineer members to the Board of Tax Appeals, set up by Congress to hear complaints of tax payers against the rulings of the Collector of Internal Revenue, was urged by the Board. Only lawyers and certified accountants are now members of the Board of Tax Appeals, and only representatives of these two classes can practice before it. Engineering problems largely concern this body, it is pointed out, and engineering membership is held essential.

The Board adopted the report of the Patents Committee urging the prompt passage by Congress of Bills H. R. 9221

and S. 3363 for the purpose of raising the salaries of the federal judges.

The report of the Coal Storage Committee, now available in published form, was finally sanctioned.

The Topeka Engineers Club was admitted to membership in American Engineering Council.

A proposal to appoint a member of a committee of the American Construction Council to further better building was declined.

The Administrative Board voted to invite the founder and other national societies to cooperate in compiling an authoritative and comprehensive pamphlet on the compensation of engineers. A committee of five to seven will be formed to direct the work.

A conference of secretaries of engineering societies will be held in Washington on the day preceding the annual meeting of the A. E. C. Assembly. A committee of five engineering society secretaries will be named to develop the program for the conference.

Action of the executive secretary in requesting engineering societies to consider the proposal to form a world federation of engineers was approved. This action was taken at the request of Dr. Sykora, president of the Engineers and Architects Association of Czechoslovakia.

A proposal that the American Engineering Council withdraw from participation in the work of the National Board for Jurisdictional Awards was referred to a special committee.

Reports of officers of American Engineering Council were approved and considerable minor business transacted during the meeting. The outlook for progressive development of the Council was described by President James Hartness as encouraging.

Two joint meetings with the engineers of Chicago supplemented the Administrative Board's sessions. At a noonday meeting at the Auditorium Hotel the speakers were President James Hartness; Fred R. Low of New York, president of the American Society of Mechanical Engineers; and F. D. Copeland, of Chicago, past president of the Western Society of Engineers.

Bulletin on Lumber Standards Recommendations

THE division of simplified practice of the U. S. Department of Commerce has issued an announcement that Simplified Practice Recommendations No. 16, containing the recommendations for lumber standards approved by the Central Committee on Lumber Standards is now in the final process of printing and will be delivered about November 1.

General adoption of the recommendations depends very largely on the distribution of the lumber standards bulletin. Members of this Society should arrange with the Superintendent of Documents, Government Printing Office, Washington, for their copies.

Cold Storage Report Ready

THE report of the Committee on Storage of Coal of American Engineering Council, entitled "Industrial Coal—Purchase, Delivery, and Storage," is now ready for distribution. The list price of the report is $5.00.

Personals

Daniel Scoates, professor of agricultural engineering, A. & M. College of Texas, was appointed last February as secretary of the Texas Hardware and Implement Association. The association has a membership of one thousand dealers and a great deal of progress has been made in reorganizing it on a firm foundation since Prof. Scoates became its secretary.

Stanley F. Morse, consulting agricultural engineer, New York City, is at present on an inspection trip in Cuba in connection with his activities.

New A. S. A. E. Members

J. J. Koodriaftseff, agricultural engineer, Y. M. C. A. Building, Butler, Pennsylvania.

TRANSFER OF GRADE

Hobart Beresford, division of agricultual engineering, University of Idaho, Moscow, Idaho. (From Student to Associate Member.)

Percival B. Potter, department of agricultural engineering, Ohio State University, Columbus, Ohio. (From Junior Member to Member.)

Benton M. Stahl, department of agricultural engineering, Ohio State University, Columbus, Ohio. (From Student to Associate Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to applicants for the consideration of the Council prior to election.

Wallace M. Cooper, manager, Los Ganos Estate, Guantanamo Sugar Company, Guantanamo, Cuba.

TRANSFER OF GRADE

Jesse Harold Neal, instructor in agricultural engineering, University Farm, St. Paul, Minnesota. (From Student to Junior Member.)

Dale Lester Renner, principal of Albion High School, Albion, Nebraska. (From Student to Junior Member.)

A. S. A. E. Employment Service

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, 1923 graduate of Kansas State Agricultural College in agricultural engineering, desires to make a change. Work along engineering lines is preferred. Address M. S. Cook, 5406 Ferdinand Street, Chicago, Illinois. MA-121.

AGRICULTURAL ENGINEER with experience on large farms with all kinds of machinery and equipment wants position with manufacturer of farm equipment. MA-122.

AGRICULTURAL ENGINEER wants position with contractors doing work in farmstead planning and building. MA-123.

AGRICULTURAL ENGINEER open for position as sales engineer, salesman, advertising writer, or agricultural propagandist. Past experience with large agricultural firms. MA-124.

Positions Open

AGRICULTURAL ENGINEER to handle farm machinery, farm power, and related lines of work needed to fill vacancy in the department of agricultural engineering at the University of Idaho, Moscow. Man selected will have the major portion of his time taken up with teaching but will have some time and opportunities for research work. Address E. J. Iddings, dean and director, College of Agriculture.

AGRICULTURAL ENGINEER equipped with good training and experience in agricultural engineering, preferably familiar with New England agriculture, is wanted by state agricultural experiment station in one of the New England states, to take charge of experimental work on rural electrification projects. Write the Secretary of the American Society of Agricultural Engineers.

AGRICULTURAL ENGINEER to handle extension work in farm power, machinery, and land reclamation, at the Kansas State Agricultural College. If interested, send statement of training and experience. Address, Department of Agricultural Engineering, Kansas State Agricultural College, Manhattan, Kansas.